Cooling Tower Water Savings CEC Pre-rulemaking Workshop

California Statewide Utility Codes and Standards Program

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Agenda

- Measure scope
- Proposed code language
- Analysis
- LCC results

Measure Scope

- New and replacement evaporative cooling towers
- Commercial, industrial, institutional sectors
- Applies to towers that are 150 tons and larger

Proposed Code Change

There are 5 measures in the proposed code change:

- installation of conductivity- or flow-based controller
- documentation of maximum achievable cycles of concentration
- installation of flow meter on the make-up water line
- installation of overflow alarm
- installation of drift eliminators - NEW

Code Language: Part 6

Section 112: Mandatory Requirements for Space-conditioning Equipment, (e) Evaporative or Open Cooling Towers. All evaporative or open cooling towers shall be equipped with the following:

Conductivity or Flow-based Controls.

- Towers shall include installation of controls that maximize cycles of concentration based on local water quality conditions. Controls shall automate system bleed and chemical feed based on conductivity, and/or in proportion to metered makeup volume, metered bleed volume, or bleed time. Conductivity controllers shall be maintained in accordance with manufacturer’s specifications to maximize useful life and accuracy.

Code Language: Part 6 (cont'd)

Documentation of Maximum Cycles of Concentration.

- Building owner shall document the maximum cycles of concentration based on local water quality conditions, using the Energy Commission-provided calculator. The calculator determines maximum cycles of concentration based on a Langelier Saturation Index (LSI) of 2.5 or less. Building owner shall document maximum cycles of concentration on Compliance Form MECH 5C, which shall be reviewed and signed by the Professional Engineer (P.E.) of Record.

Code Language: Part 6 (cont'd)

Flow Meter.

- Towers shall include installation of a flow meter on the makeup water line.

Overflow Alarm.

- Towers shall include installation of an overflow alarm to alert operator to sump overflow in case of makeup water valve failure. Overflow alarm shall send an audible signal or provide an alert via the Building Management System to the tower operator in case of sump overflow.

Code Language: Part 6 (cont'd)

Drift Eliminators.

- Towers shall be equipped with efficient drift eliminators that achieve drift reduction to 0.002% of the circulated water volume for counterflow towers and 0.005% of the circulated water volume for cross-flow towers.

Code Language: Compliance Manual

Add section 4.2.4 Cooling Tower Controls under Section 4.2: Equipment Requirements.

- Section 4.2.4 will reference §112 in Part 6 of Title 24, and will describe the methodology or tool required to calculate maximum cycles of concentration in cooling towers based on local water conditions. It will also reference the appropriate compliance form.

Code Language: Compliance Manual

Under Section 4.5 HVAC System Control Requirements, Section 4.5.1 Mandatory Measures would require the addition of #7 Cooling Tower Water Savings Controls.

- Language to be developed that references §112 in Part 6, and will describe the methodology or tool required to calculate maximum cycles of concentration in cooling towers based on local water conditions. It will also reference the appropriate compliance form.

Section 4.10 Glossary/Reference

- Add subsection 4.10.11, including water balance in evaporative cooling towers, cycles of concentration and the Langelier Saturation Index (LSI).

MECH 1C: Certificate of Compliance

- Add a new section to HVAC equipment efficiencies (§112) in the Note Blocks for Mechanical Mandatory Measures. The section will require verification of installation of the following:
  - controls that automate blowdown and chemical feed based on conductivity and/or flow rate and/or bleed time
  - flow meter on the makeup water line
  - overflow alarm to alert operator to overflow of the sump in case of makeup water valve failure
  - drift eliminators

MECH-5C: Maximum Cycles of Concentration

- New form
- Documents maximum achievable cycles of concentration based on local water quality conditions and water quality data
- Inserted as subsection 4.11.8 or be added to the end of Section 4.11 as subsection 4.11.10

Measure Costs and EULs

Individual measure costs are not discounted. Total cost over 15 years, in present value terms, is provided in the last row of the table.

	Installed Cost (first year)	EUL (years)	15 Year Cost
Controller	$1,089	10	$2,178
Conductivity sensor	$164	3	$657
Max cycles calculation	$300	n/a	$300
Makeup flow meter	$653	15	$653
Overflow alarm	$351	15	$351
Drift eliminator	$0	9	$0
Total	$2,393		$4,139
Total (present value)			$3,624

Conductivity and Flow-based Meters: Modeling Tower Energy Load

- EnergyPro
- 9 Building Climate Zones (3,4,6,7,8,9,10,12,13) – 89% of projected new construction for office space
- 117,000 sqft conditioned space
- Office – cooling operation 6am – 6pm, 7 days per week
  - per Table N2-8 in T24 ACM
- Chiller capacity: 239 – 292 tons, depending on BCZ
- Tower capacity: 280 – 339 tons, depending on BCZ
- Condenser water flow: 691 – 845 gpm, depending on BCZ
- Outputs: OADB, OAWB, condenser water load, chiller load

Conductivity and Flow-based Meters: Modeling Tower Water Use

- Excel-based model provided by tower manufacturer to Taylor Engineering, who modified it for own use
- Allows manipulation of cycles of concentration and drift
- Output: annual bleed rate
- Developed model for each of 9 BCZs
  - Drift = 0.005%
  - One run with 3.5 cycles, one run with 4.9 cycles
- Calculated bleed savings for each BCZ, then calculated weighted average according to new construction
- Results scaled to represent a 350 ton tower

Documenting Max Cycles of Concentration

- Assumed 2 hours of time to procure local water quality data, enter it into calculator, and document in form
- Measure assumed to work in tandem with controls – no additional savings attributed

Flow Meter on Makeup Water Line

- Measure assumed to work in tandem with controls to help identify uncontrolled losses and manage water chemistry
- Unable to find data on uncontrolled water losses
- No additional savings attributed

Overflow Alarm on Tower Sump

- Prevents uncontrolled water losses in case of makeup valve failure
- Unable to find data on uncontrolled water losses
- No additional savings attributed

Drift Eliminators

- Require installation of drift eliminators that achieve drift reduction to 0.002% of the circulated water volume for counterflow towers and 0.005% for cross-flow towers
- “No incremental cost, no incremental savings” measure

LCC Analysis

- Included water and chemical savings
  - Chemical savings calculated relative to bleed savings
  - Chemical concentration maintained at 100 ppm; ~1 gallon of scale inhibitor per 12,000 gallons of bleed water
  - 10# chemical/ gallon
  - Cost: $2/#
- Embedded energy savings were calculated but not included in LCC

Notes on Results

Analysis is conservative – water savings are probably understated.

- Industrial water rate was used, which was lower than the commercial water rate
- Cooling tower energy use - and by extension, water use – modeled for an office building only; however, cooling towers serving the industrial sector have longer operating hours and would experience higher savings as a result of these efficiency measures.
- Did not include water efficiency incentives or evaporation credits from water utilities

LCC Results

a	b		c		d	e	
Measure Name	Additional Costs– Current Measure Costs (Relative to Basecase) ($)		PV of Additional Maintenance Costs (Savings) (Relative to Basecase) (PV$)		PV of **Water and Chemical** Cost Savings – Per Proto Building (PV$)	LCC Per Prototype Building ($)	
	Per Unit	Per Proto Building	Per Unit	Per Proto Buildin g		(c+e)-f Based on Current Costs	(d+e)-f Based on Post-Adoption Costs
Cooling Tower Measures	$3,624	$3,624	$0	$0	$11,165	$(7,540)	$(7,540)

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QUESTIONS & COMMENTS

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